

Gerbillurus setzeri.

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Gerbillurus setzeri Schlitter, 1973

Setzer's Hairy-footed Gerbil

Gerbillus (Gerbillurus) setzeri Schlitter, 1973:13. Type locality, "one mile east of the Namib Desert Research Station, Gobabeb, Namibia."

CONTEXT AND CONTENT. Order Rodentia, Family Muridae, Subfamily Gerbillinae, Tribe Taterillini, Subtribe Gerbillurina, Genus *Gerbillurus*, Subgenus *Gerbillurus*. *G. setzeri* is monotypic (Meester et al., 1986); however, a distinctive gray form has been recognized from sites between the Swakop and Kunene rivers (Griffin, 1990). This is probably the form mentioned by Coetze (1969). *G. setzeri* was described in 1973 (Schlitter, 1973); in previous literature it was referred to as *Gerbillus* (or *Gerbillurus*) *vallinus* (Coetze, 1969; Lundholm, 1955; Meester, 1963; Roberts, 1951).

DIAGNOSIS. *Gerbillurus setzeri* is similar in color to *G. paeba* where they coexist, but *G. setzeri* is distinguished from *G. paeba* by its larger size with adult mass ca. 30–40 g (20–30 g in *G. paeba*). The tail brush of *G. setzeri* is more pronounced than that of *G. paeba* (Fig. 1—Griffin, 1990). In areas where *G. setzeri* and *G. paeba* coexist, both species have a pale cinnamon coat color (Schlitter, 1973), but *G. setzeri* has longer and thicker fur than *G. paeba* (Schlitter et al., 1984).

Gerbillurus setzeri has the largest head and body length (105.7 mm) of all *Gerbillurus* species (Schlitter, 1973). Its tail is shorter relative to head and body length than either *G. tytonis* or *G. vallinus* (20%, 30%, 40%, respectively—Schlitter, 1973). Dorsal pelage of *G. setzeri* is paler in color than either *G. tytonis* or *G. vallinus* (Schlitter, 1973).

Cranially, *G. setzeri* is distinguished from other *Gerbillurus* species by having the greatest overall length (31.4 mm) and the greatest development of the bullae (oblique length 11.4 mm—Griffin, 1990; Schlitter, 1973). *G. setzeri* is further distinguished from *G. tytonis* by having longer palatal foramina (Schlitter, 1973).

GENERAL CHARACTERS. Setzer's hairy-footed gerbil is a robust, hairy-footed gerbil with a long and bushy tail. Upper parts of the body are light brown or beige, never brown or red (Griffin, 1990). Areas around the mouth, dorsal surface of the limbs, and underparts are white. White supraorbital and post-auricular spots are clearly defined (Skinner and Smithers, 1990). Colors of the upper and underparts are clearly demarcated. A bushy tip or brush

is present on the tail, which is often silver gray on the dorsal surface.

Mean and range of external measurements (in mm) for *G. setzeri* are as follows: total length, 233.0 (217–263, $n = 43$); length of tail, 127.4 (113–145, $n = 43$); length of hind foot, 32.5 (30–35, $n = 44$); length of ear from notch, 13.9 (12–16, $n = 43$)—Schlitter, 1973. Cranial measurements (mean and range) in mm for *G. setzeri* are: occipitonasal length, 31.4 (29.5–32.6, $n = 23$); breadth across zygomatic arches, 16.6 (15.7–17.4, $n = 29$); greatest breadth of braincase, 14.9 (14.1–16.1, $n = 31$); least interorbital breadth, 5.6 (5.3–5.9, $n = 35$); breadth of rostrum, 4.1 (3.6–4.3, $n = 33$); greatest length of nasals, 12.3 (11.4–13.1, $n = 29$); oblique length of auditory portion of auditory bulla, 11.4 (10.6–12.4, $n = 35$); crown length of maxillary toothrow, 4.3 (4.1–4.6, $n = 19$); breadth of palate at M3, 5.1 (4.9–5.3, $n = 7$); length of anterior palatal foramina, 5.5 (5.0–6.1, $n = 34$); length of posterior palatal foramina, 2.3 (1.8–2.7, $n = 36$); greatest height of skull 13.2 (12.7–13.8, $n = 22$); breadth of auditory bulla, 9.0 (8.1–9.7, $n = 35$)—Schlitter, 1973; Fig. 2). Mean body mass is 32.9 g ($n = 16$)—Downs and Perrin, 1990a) and 38.6 g ($n = 3$ females—de Graaff, 1981).

DISTRIBUTION. *Gerbillurus setzeri* is endemic to the Namib Desert ranging northwards from the Kuiseb River to southern Angola (Fig. 3). Specimens have been trapped at Gobabeb on the gravel plains north of the Kuiseb River in the Namib Desert (Downs and Perrin, 1989; Schlitter, 1973). *G. setzeri* has also been trapped south of the Kuiseb River at Charre (M. Griffin, in litt.). Although specimens disperse from the gravel plains across the riverbed into adjacent red sand dunes (Schlitter, 1973), this is most likely a rare event (Boyer, 1987). The southern limit of distribution is the narrow gravel/sand plain corridor between the Gaub and Tsondab rivers (Griffin, 1990). *G. setzeri* has been recorded from Swartbank Mountain, Tumas Mountain near Swakopmund, at Goanikontes, and at Hope Mine (Schlitter, 1973). The distribution includes the Iona National Park in the northwestern Namib Desert of Angola (Skinner and Smithers, 1990). Distribution records of *G. vallinus* from central and northern Namibia, Damaraland, Kaokoland, and Angola (Crawford-Cabral, 1986) almost certainly refer to *G. setzeri*. No fossils of *G. setzeri* are known.

FORM AND FUNCTION. Dental formula is i 1/1, c 0/0, p 0/0, m 3/3, total 16. Preferred ambient temperature is ca. 28°C. Thermal parameters are as follows: thermoneutral zone, 32.2°C; predicted lower critical temperature, 28.4°C; basal metabolic rate, 0.803 ml O₂ g⁻¹ h⁻¹; minimal conductance, 0.152 ml O₂ g⁻¹ h⁻¹ °C⁻¹ (Downs and Perrin, 1990b). Above ambient temperatures of 35°C, dry thermal conductance increases sharply, but hyperthermia may occur. *G. setzeri* salivates, wetting the neck region to aid cooling through evaporation, which is accompanied by peripheral vasodilation and piloerection (Downs and Perrin, 1990b). Exposure to ambient temperatures $\geq 40^\circ\text{C}$ for periods > 1 h results in death. Pulmocutaneous water loss is low below ambient temperatures of 35°C, but increases sharply thereafter. The small rate of increase of oxygen consumption and the sharp increase in thermal conductance at temperatures above the thermoneutral zone reflects an avoidance of evaporative water loss that reduces overheating. The relatively large size and thick pelage of *G. setzeri* (Schlitter et al., 1984) may facilitate thermal conductance (Downs and Perrin, 1990b). The large body size of *G. setzeri* for the genus *Gerbillurus* reduces the difference between total water loss and metabolic heat production.

Gerbillurus setzeri has a daily energy expenditure slightly lower than predicted (93%) and lower water turnover rate than other species within the genus (Downs and Perrin, 1990b). Water turnover rate varies with protein and water content of the diet (Downs and



FIG. 1. *Gerbillurus setzeri*, photographed by A. Bruton.

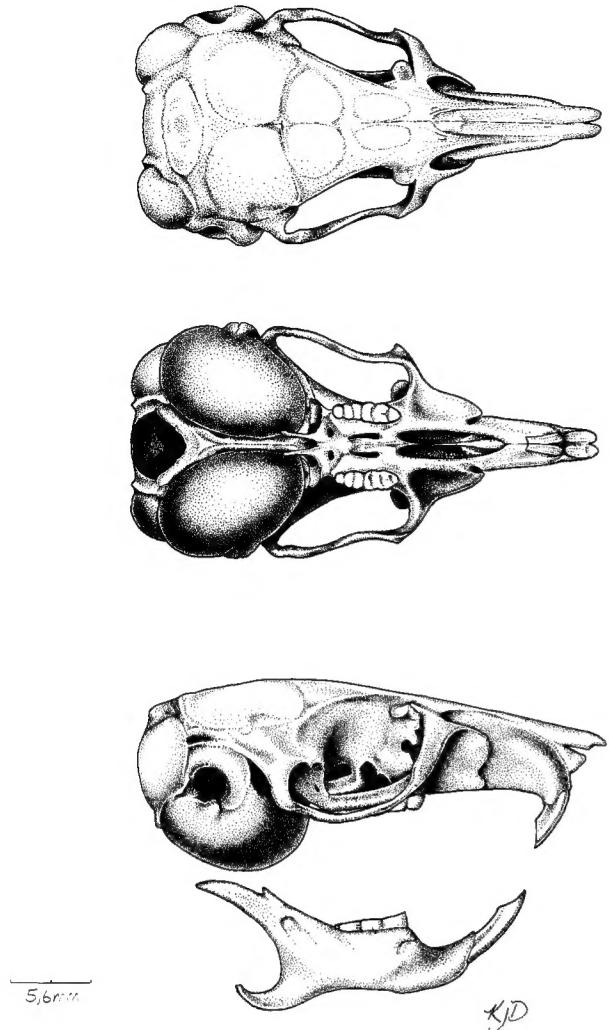


FIG. 2. Dorsal, ventral, and lateral views of cranium and lateral view of mandible of *Gerbillurus setzeri*. Greatest length of cranium is 31.4 mm.

Perrin, 1990c). On millet seed, sunflower seed, and mealworm diets (all diets without drinking water but supplemented with carrot) water turnover rate is 102.2, 115.0, and 200.5 ml kg⁻¹ day⁻¹, respectively. Field water turnover rate of *G. setzeri*, 76.9 ml kg⁻¹ day⁻¹, is lower than for *G. paeba* and *G. tytonis* and lower than rates in the laboratory (Downs and Perrin, 1990a).

Urine production in *G. setzeri* varies with diet from 0.76 ml/day on a diet of mealworms to 0.06 ml/day on a diet of sunflower seeds (each supplemented with carrots). Fecal water loss is 0.0869 and 0.0026 ml/g of body mass respectively. Mean urine osmolality (osmol/kg) was 2.04, 3.50, and 4.19 on diets of mealworms, sunflower seeds, and millet seeds (supplemented with carrot, no drinking water available), respectively. Mean urea concentration was higher on a diet of mealworms (2.32 mM/ml) than on a diet of sunflower seeds (1.67 mM/ml). Urinary concentrating ability is enhanced by the conversion of urea to allantoin (Downs and Perrin, 1991). *G. setzeri* has the greatest urine concentrating ability of all *Gerbillurus* species. The high urine concentrating ability is confirmed by renal indices. *G. setzeri* has greater relative (Sperber, 1944) and percentage (Heisinger and Breitenbach, 1969) renal medullary thicknesses than other *Gerbillurus* species (Downs and Perrin, 1991). The loop of Henle and papilla renis are unusually long, accounting for the remarkable urine concentrating ability (Downs and Perrin, 1991). Low water turnover rate, low fecal water loss, and high urinary concentrating ability enable *G. setzeri* to survive indefinitely in arid environments without free water (Downs and Perrin, 1990c, 1991).

ONTOGENY AND REPRODUCTION.

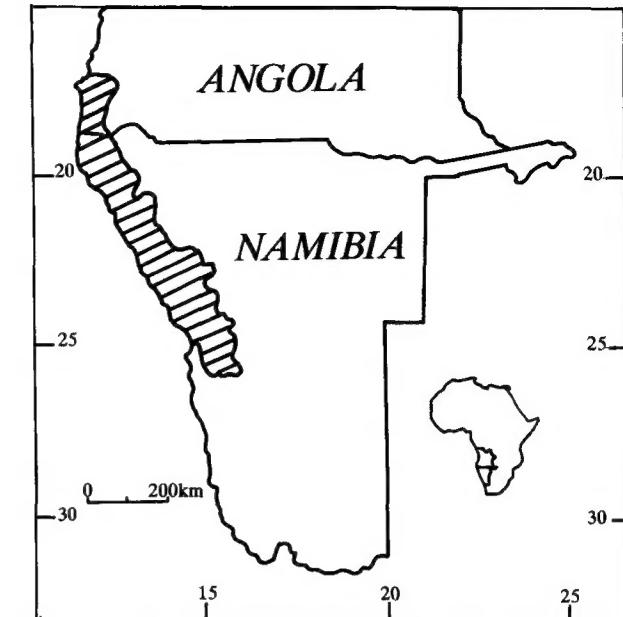


FIG. 3. Distribution of *Gerbillurus setzeri* in southern Africa.

ductive condition may be present at any season (Griffin, 1990). Copulation was observed in one pair of *G. setzeri* in the laboratory (Dempster, 1990). *G. setzeri* exhibits an unusual copulatory pattern of a single ejaculation, lock and deposition of a copulatory plug. The male clasped the female around the abdomen and lifted the female's abdomen while making pelvic thrusts; several deep thrusts indicated that intromission had occurred. Pelvic thrusting ceased once a lock had occurred. The single intromission led to a single ejaculation. A copulatory plug was visible in the vagina after copulation. The copulation observed resulted in pregnancy.

Gestation in *G. setzeri* is 21 days. Data on postnatal development and maternal behavior are available for only one litter (Dempster and Perrin, 1991a). The litter size of three was within the range of from one to six recorded for other *Gerbillurus* species (Dempster and Perrin, 1989a). Individual young weighed an average 2.3 g at birth and grew at a rate of 0.7 g/day during the first 23 days of life. Nipple-clinging did not occur (Dempster and Perrin, 1991a). Neonates are altricial, and their eyes open at ca. 18 days of age. Weaning occurs between 23 and 28 days. Ultrasonic calling by young was recorded at frequencies between 45 and 55 kHz.

ECOLOGY. *Gerbillurus setzeri* occurs in hot, dry areas where mean annual temperature is >18°C (Downs and Perrin, 1989). Burrows create a microenvironment that is buffered from extremes of temperature while humidity is elevated. Burrows of *G. setzeri* are often complex, 90% are branched, and they are longer (maximum, 214 mm) and deeper (maximum, 392 mm) than those of other *Gerbillurus* species (Downs and Perrin, 1989). Burrows often occur in dry river washes where the substrate is loose and gravelly, although surface soil is compact and fine (Downs and Perrin, 1989).

Gerbillurus setzeri prefers semi-compacted, gravel plains which lack vegetation (Griffin, 1990). Soils have been described as shallow and calcareous with a slight gypsum crust and a grit blanket (Scholz, 1972). Occasionally *G. setzeri* colonize sand dunes during periods of high gerbil densities (Griffin, 1990; Schlitter, 1973). After rains, areas occupied predominantly by *G. setzeri* are colonized by other gerbils (Griffin, 1990). At low densities, *G. setzeri* and *G. paeba* occur sympatrically, but as population densities increase, one species migrates from the area. Segregation may be related to habitat change rather than displacement (Griffin, 1990). *G. setzeri* may co-occur with short-eared elephant shrews (*Macroscelides proboscideus*) on semi-compacted calcareous soils (Griffin, 1990).

Little information is available on the diet of *G. setzeri*. Stomach contents of five individuals collected in March 1988 from the gravel plains near Gobabeb comprised 50% arthropods, 40% plant material, and 10% seeds (Perrin et al., 1992). According to Griffin (1990), *G. setzeri* is primarily granivorous but regularly ingests arthropods and leafy material, although stomachs taken from a pop-

ulation at Donkerhoek contained only arthropod material. Caches from excavated burrows at Rossing in central Namibia contained leaves, flower heads, and the dry fruits of *Tetragonia reduplicata*; seeds, bracts, and twigs of *Blepharis grossa*; leaves, twigs, and seed pods of *Acacia reficiens*; chewed grass; sheaths of bulbs; insect elytra; and tenebrionid beetles (Downs and Perrin, 1989).

No detailed data are available on density, demography, or spatial use of *G. setzeri*. Trapping success in suitable habitat varies from 4% in wet years to 0.1% in drought years (Griffin, 1990). High trap success (9%) was recorded on the farm Donkerhoek during a 3-month period, and on the gravel plains north of the Kuiseb River near Gobabeb during March 1988 (C. T. Downs, in litt.).

BEHAVIOR. When alarmed, *G. setzeri* patter their hind feet on the substrate using very rapid alternate movements (Dempster and Perrin, 1990a). During sandbathing the animals roll rapidly from flank to dorsum with a flick in the sand. *G. setzeri* also performs a side rub which involves sliding the flank along the sand. Digging in the sand with the forepaws and kicking sand back with the hind feet occurs frequently. The primary form of locomotion is quadrupedal saltation. Nests are constructed of shredded grass and husks of seeds; seeds are cached at specific sites (Dempster and Perrin, 1990a).

Gerbillurus setzeri is semi-tolerant of conspecifics and its behavior is intermediate between that of the aggressive and solitary *G. paeba* and *G. tytonis* and the tolerant *G. vallinus* (Dempster and Perrin, 1989b). The semi-tolerant behavior and complex burrows of *G. setzeri* suggest a degree of sociality not found in dune dwelling *G. paeba* or *G. tytonis*. *G. setzeri* inhabits more extreme environments than solitary *Gerbillurus* species.

Male-female interactions exhibit similar levels of agonistic behavior for each sex (Dempster and Perrin, 1989c). The behavior of *G. setzeri* in staged encounters with conspecifics is characterized by low levels of sexual and exploratory behavior and high levels of attentive behavior (Dempster et al. 1992). *G. setzeri* lacks the contact-promoting behavior of *G. vallinus*, and allogrooming is not performed. Male-female aggression is more intense in *G. setzeri* than *G. vallinus*; *G. setzeri* may be less colonial than *G. vallinus* (Dempster and Perrin, 1989c). *G. setzeri* does not identify conspecifics by deposited chemosignals (Dempster and Perrin, 1990b).

Gerbillurus setzeri vocalizes at ultrasonic frequencies by means of a strongly modulated call with a frequency sweep, which differs from congeners in duration and maximum and minimum frequency (Dempster and Perrin, 1991b). Only one call type was identified from *G. setzeri* a whistle which began at ca. 49 kHz and ended at ca. 39 kHz. Mean duration of a call was 117 msec (Dempster and Perrin, 1991b).

Vocalizations were positively associated with sexual and huddling behavior in *G. setzeri*, but vocal emissions were inhibited during aggressive and submissive bouts which entailed much physical activity (Dempster et al., 1991). Vocalizations preceded copulation but were undetected during and immediately after copulation.

GENETICS. The diploid chromosome number is 60 and the number of autosomal arms varies between 76 and 82 (Qumsiyeh et al., 1991; Schlitter et al., 1984). *G. setzeri* and *G. vallinus* share the same diploid number, but *G. vallinus* is variously reported as having 70–74 autosomal arms (Qumsiyeh et al., 1991) or 80 autosomal arms (Schlitter et al., 1984). Chromosomes include 20 pairs of acrocentrics and 9 pairs of metacentrics and submetacentrics (Schlitter et al., 1984). G- and C-banding of chromosomes of three individuals revealed that two specimens had 20 biarmed autosomes, while a third specimen from the same locality had 24 biarmed autosomes. *G. setzeri* has the following unique derived chromosomal characteristics: a centric fission in 11/12 and translocations to 1, 7/8, 14, and 29 (Qumsiyeh et al., 1991).

REMARKS. The generic name is derived from the French *gerbille* meaning a small gerbil. The suffix *urus* denotes "as belonging to" (de Graaff, 1981). The species is named after Dr. H. W. Setzer in honor "of his efforts in African taxonomy and in particular for his interest in the taxonomy of desert rodents" (Schlitter, 1973:17). Skulls in Fig. 2 were drawn by Karen Duxbury.

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